15-410

"...Goals: Time Travel, Parallel Universes..."

Source Control
Feb. 6, 2008

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Outline

Motivation

Repository vs. Working Directory

Conflicts and Merging

Branching

PRCS –Project Revision Control System

Goals

Working together should be easy

Time travel

- **Useful for challenging patents**
- ***Very*** **useful for reverting from a sleepless hack session**

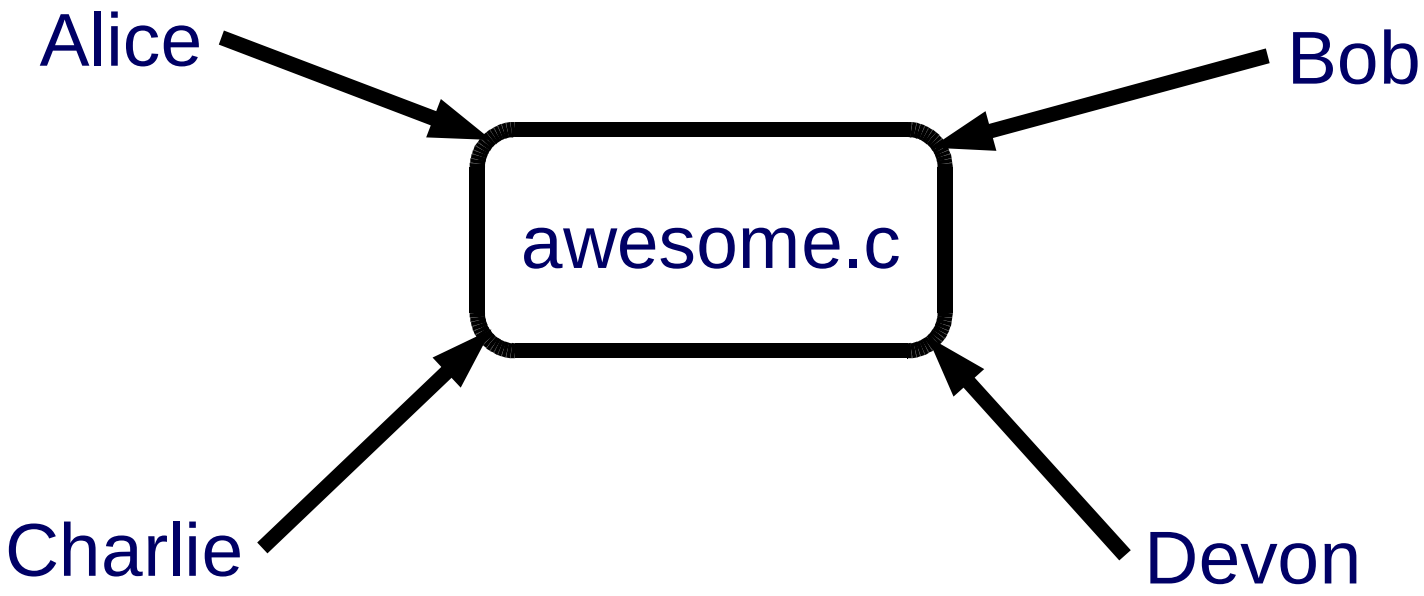
Parallel universes

- **Experimental universes**
- **Product-support universes**

Goal: Shared Workspace

Reduce development latency via parallelism

- **[But: Brooks, Mythical Man-Month]**



Goal: Time Travel

Retrieving old versions should be easy.

Once Upon A Time…

Alice: What happened to the code? It doesn't work.

Charlie: Oh, I made some changes. My code is 1337!

Alice: Rawr! I want the code from last Tuesday!

Goal: Parallel Universes

Safe process for implementing new features.

- **Develop bell in one universe**
- **Develop whistle in another**
- **Don't inflict B's core dumps on W**
- **Eventually produce bell-and-whistle release**

How?

Keep a global repository for the project.

The Repository

Version / Revision / Configuration

- Contents of some files at a particular point in time
- aka “Snapshot”

Project

- A “sequence” of versions
  - (not really)

Repository

- Directory where projects are stored

The Repository

Stored in group-accessible location

- **Old way: file system**
- **Modern way: “repository server”**

Versions *in repository* visible group-wide

- **Whoever has read access**
- **“Commit access” often separate**

How?

Keep a global repository for the project.

Each user keeps a working directory.

The Working Directory

Many names (“sandbox”)

Where revisions happen

Typically belongs to *one* user

Versions are *checked out* to here

New versions are *checked in* from here

How?

Keep a global repository for the project.

Each user keeps a working directory.

Concepts of checking out, and checking in

Checking Out. Checking In.

Checking out

- A version is copied from the repository
  - Typically “Check out the latest”
  - Or: “Revision 3.1.4”, “Yesterday noon”

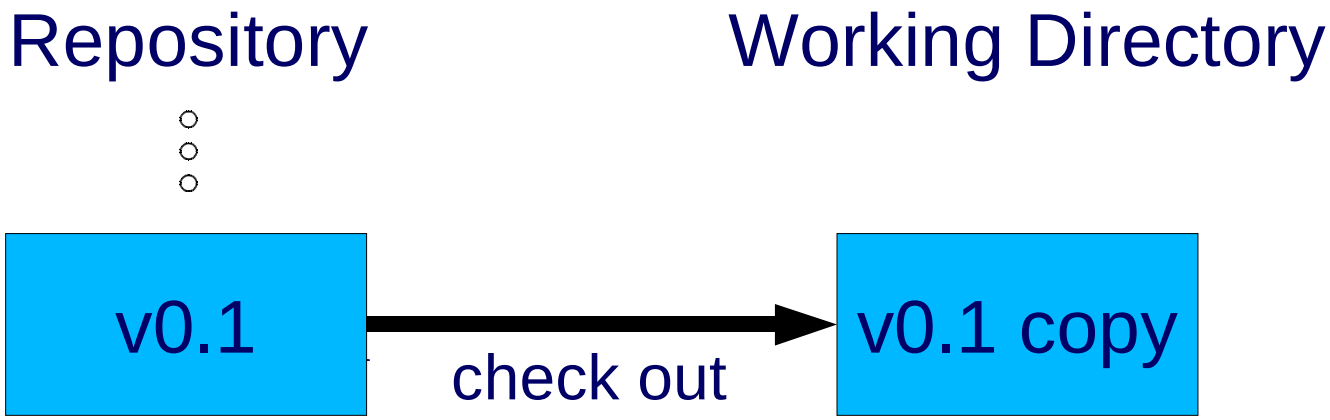
Work

- Edit, add, remove, rename files

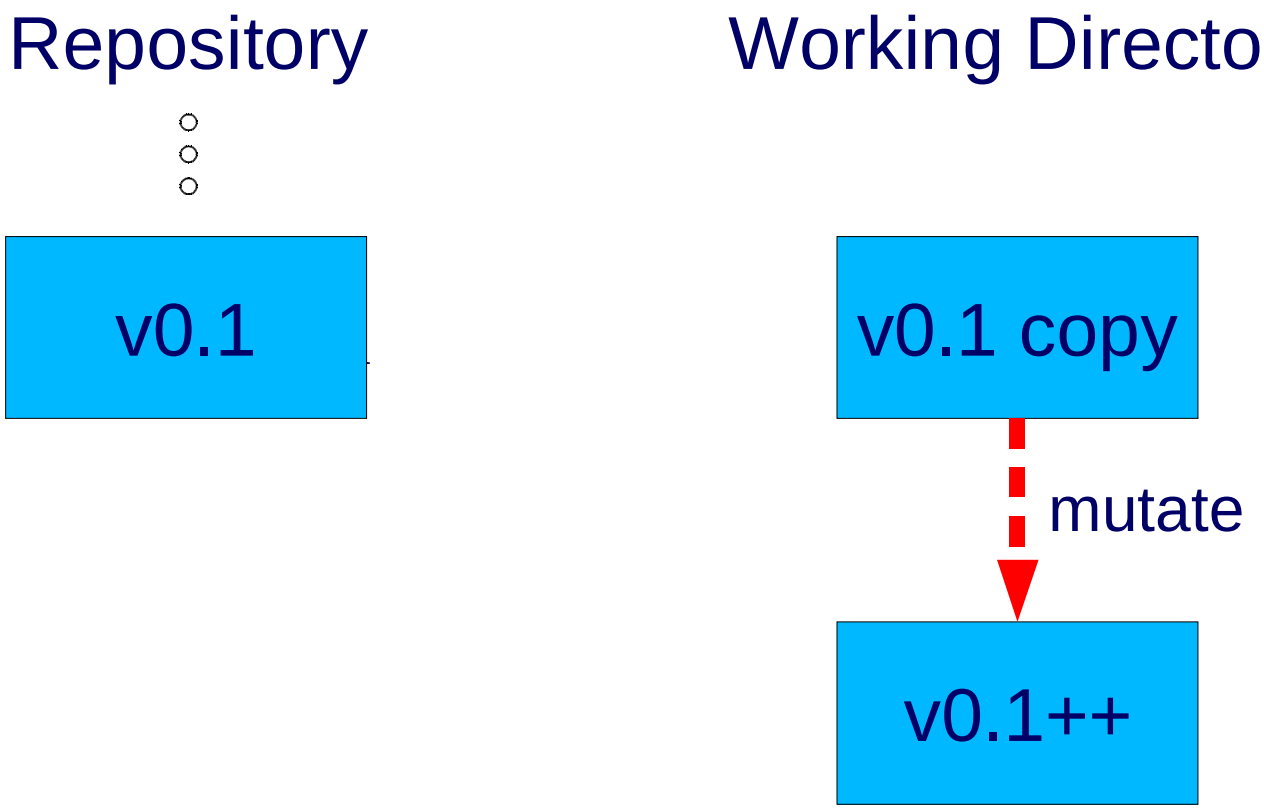
Checking in

- Working directory ⇒ repository *atomically*
- Result: new version

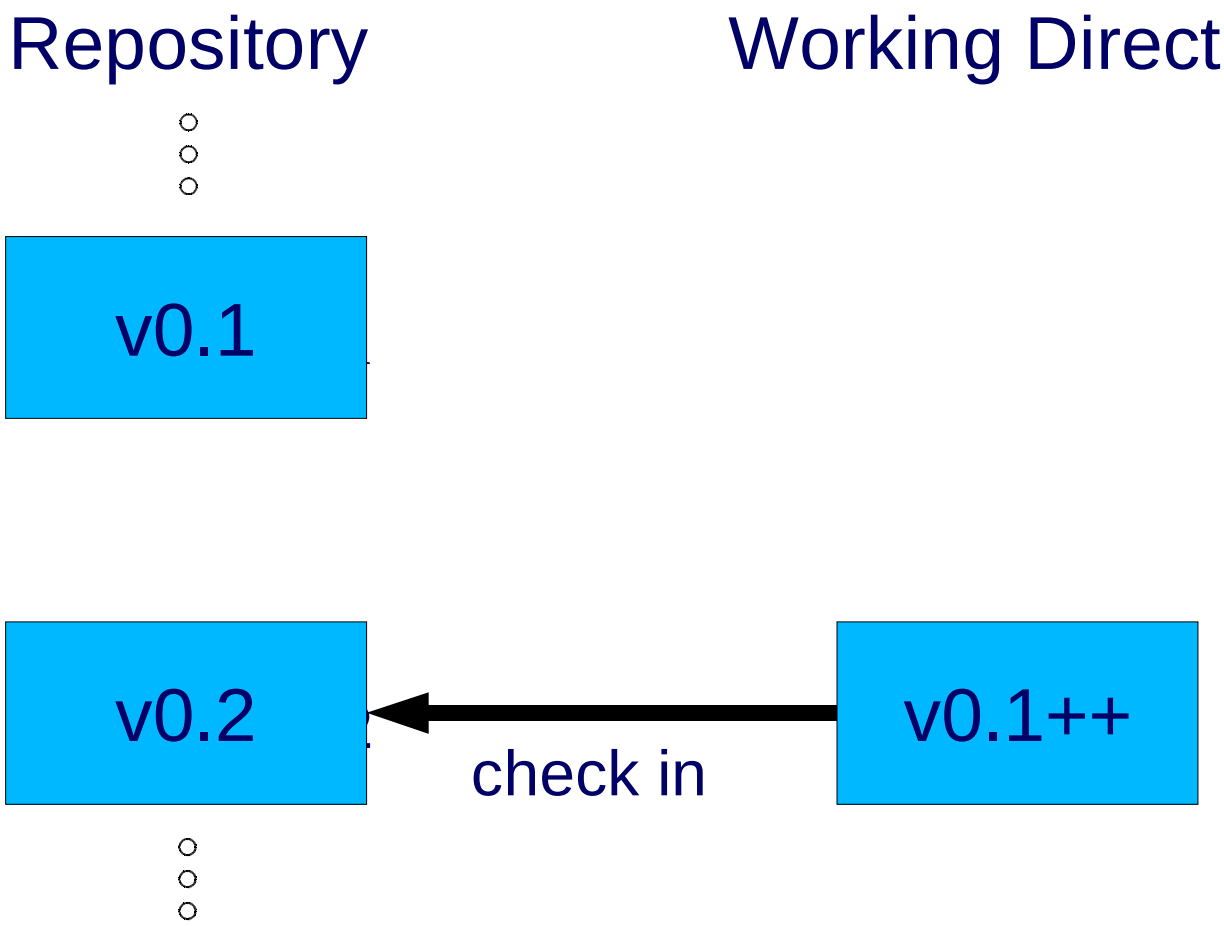
Checking Out. Checking In.



Checking Out. Checking In.



Checking Out. Checking In.



How?

Keep a global repository for the project.

Each user keeps a working directory.

Concepts of *checking out*, and *checking in*

Mechanisms for merging

Conflicts and Merging

Two people check out.

- **Both modify foo.c**

Each wants to check in a new version.

- **Whose is the *correct* new version?**

Conflicts and Merging

Conflict

- Independent changes which “overlap”
- *Textual* overlap detected by revision control
- *Semantic* conflict cannot be

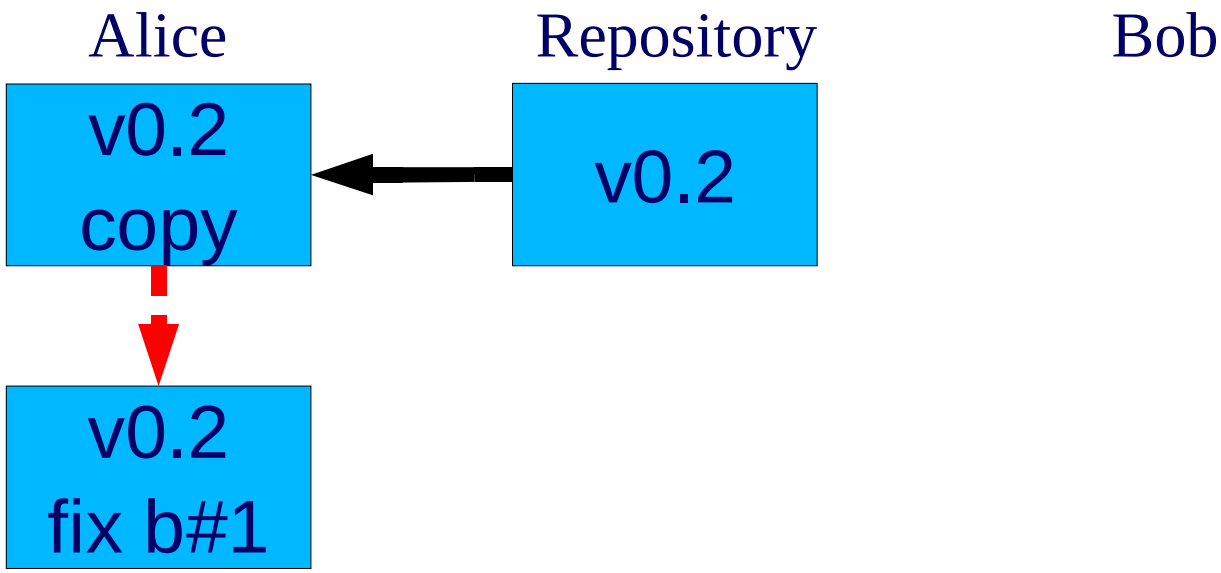
Merge displays conflicting updates per file

Pick which code goes into the new version

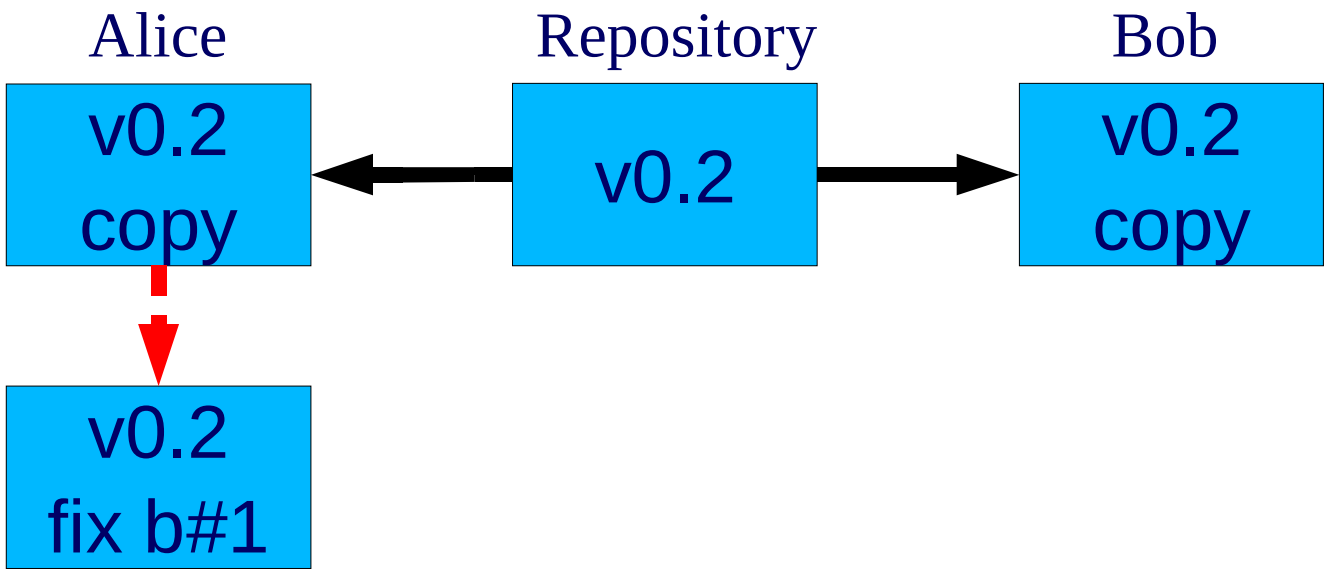
- A, B, NOTA

Story now, real-life example later

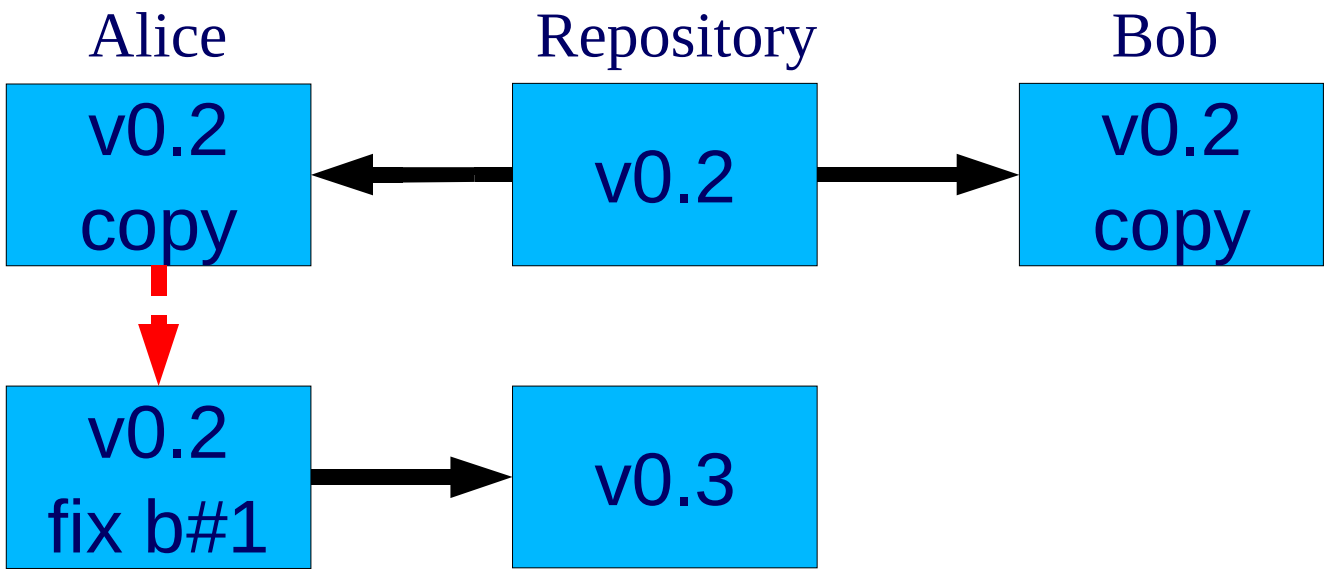
Alice Begins Work



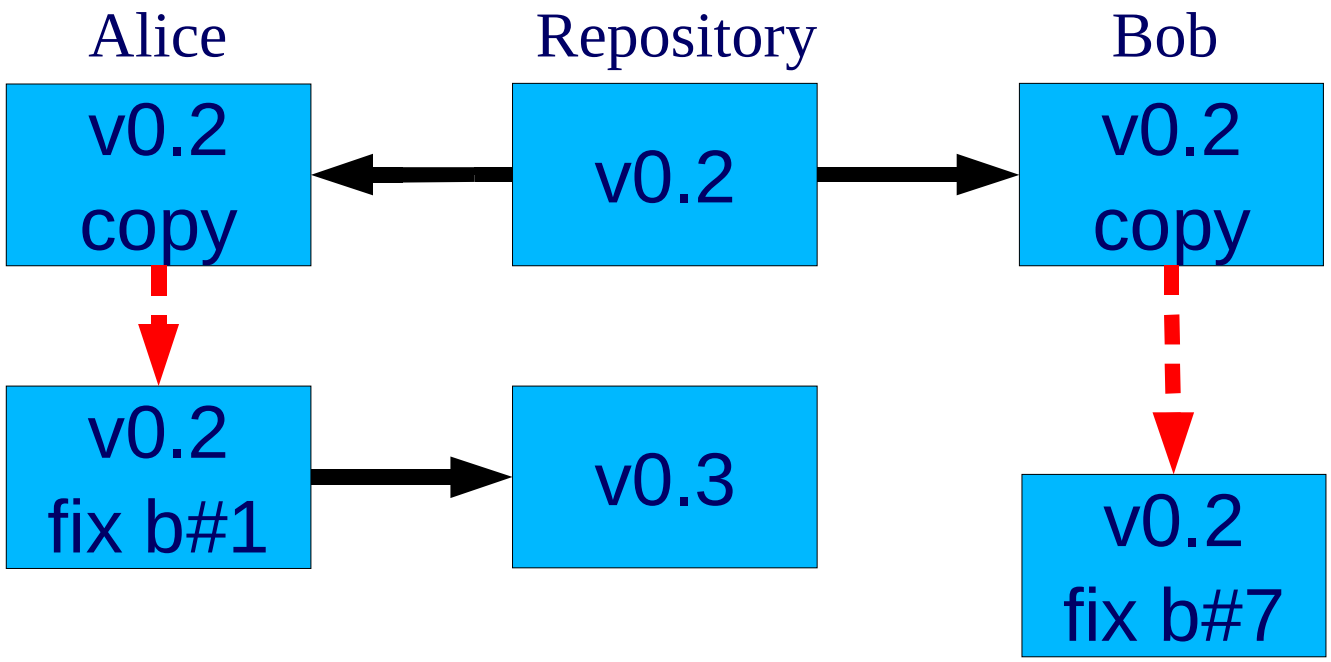
Bob Arrives, Checks Out



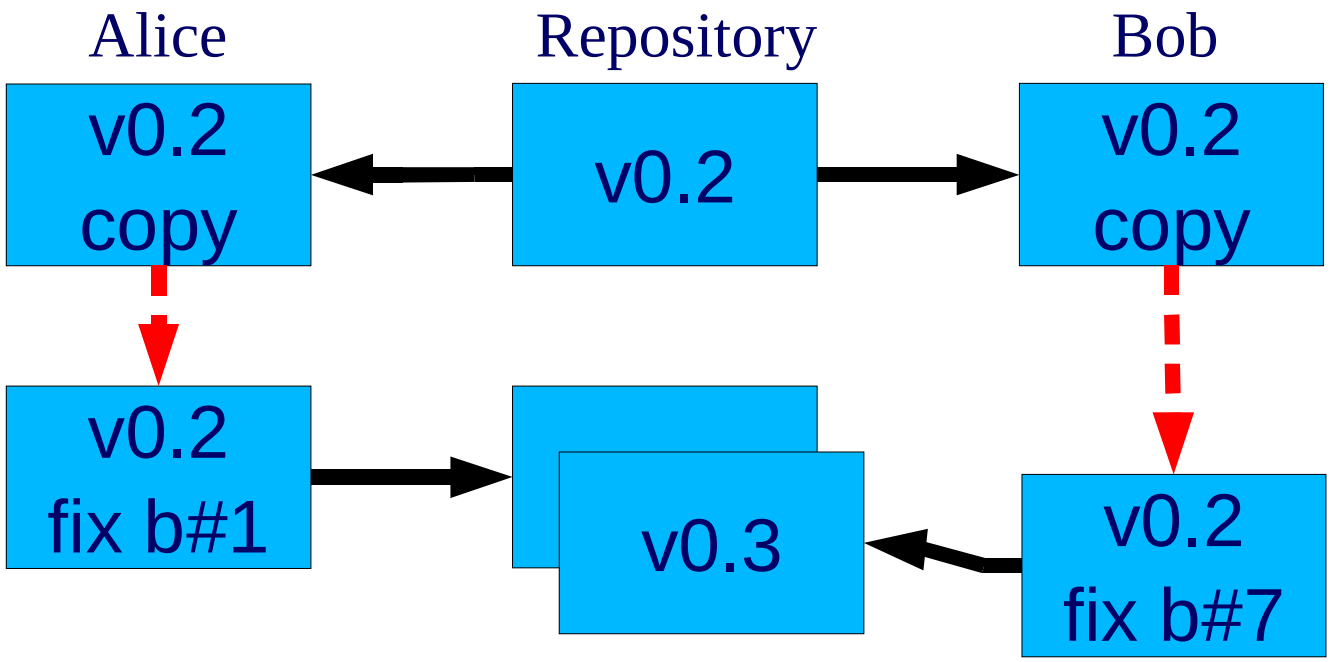
Alice Commits, Bob Has Coffee



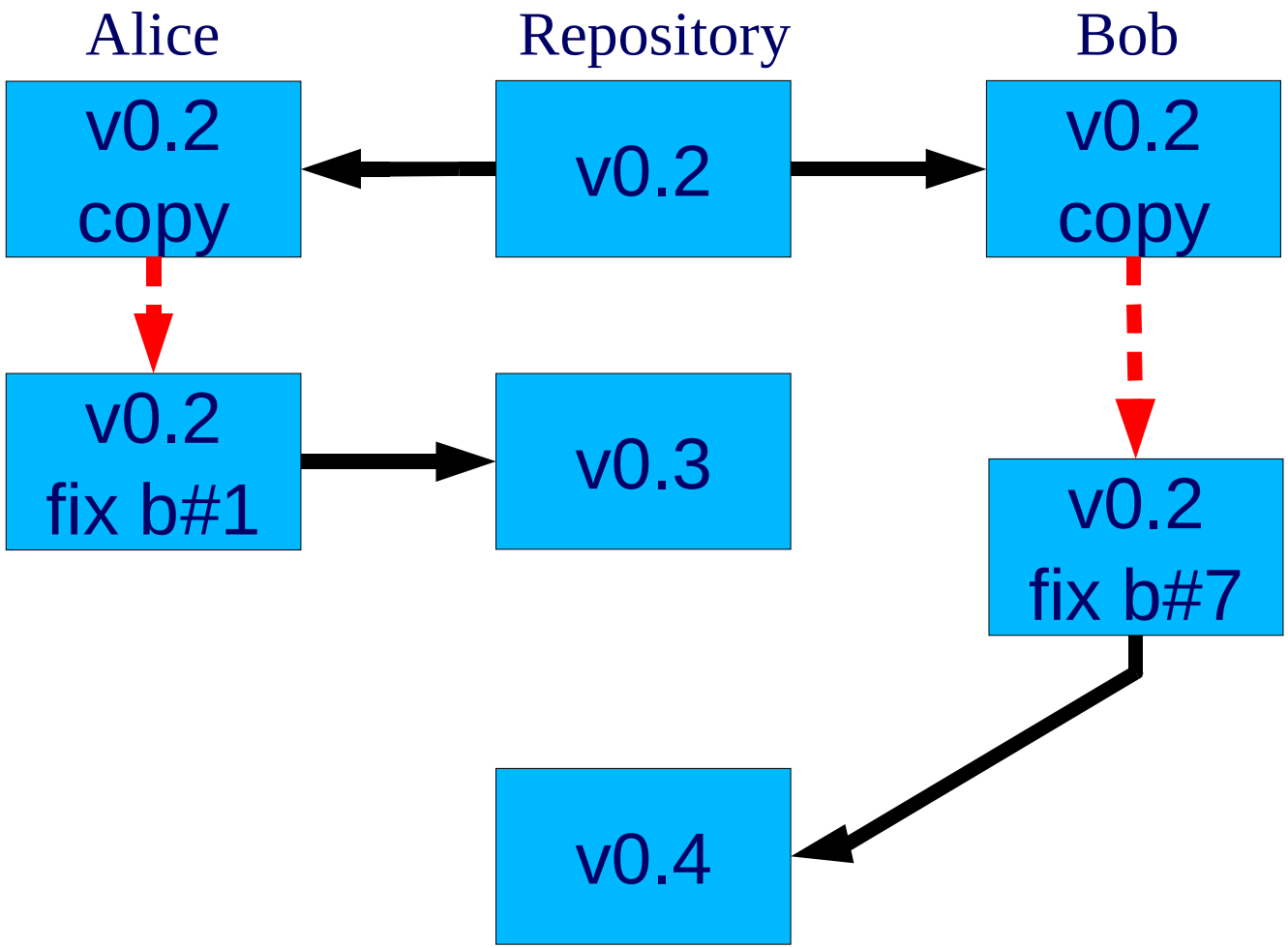
Bob Fixes Something Too



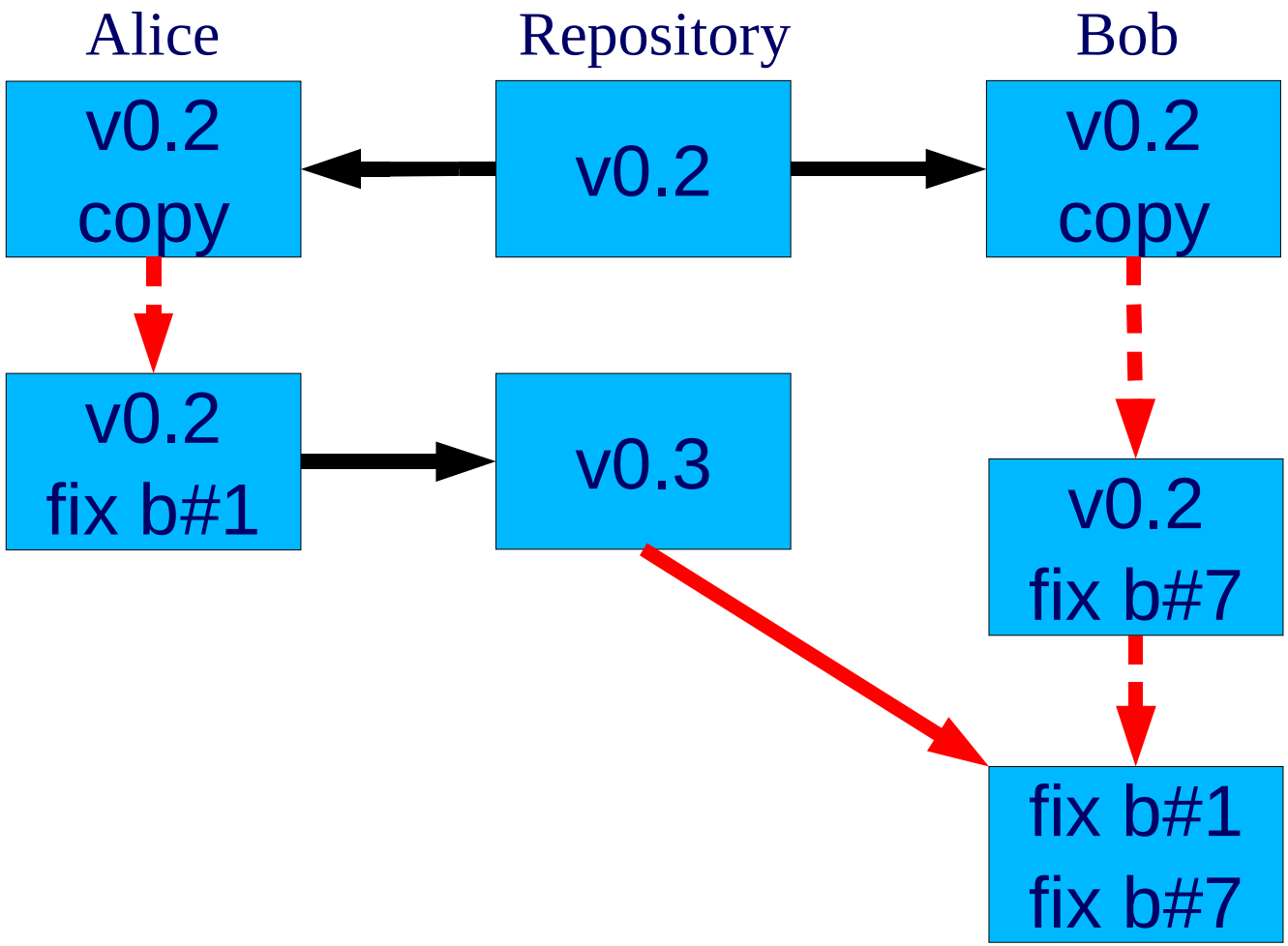
Wrong Outcome



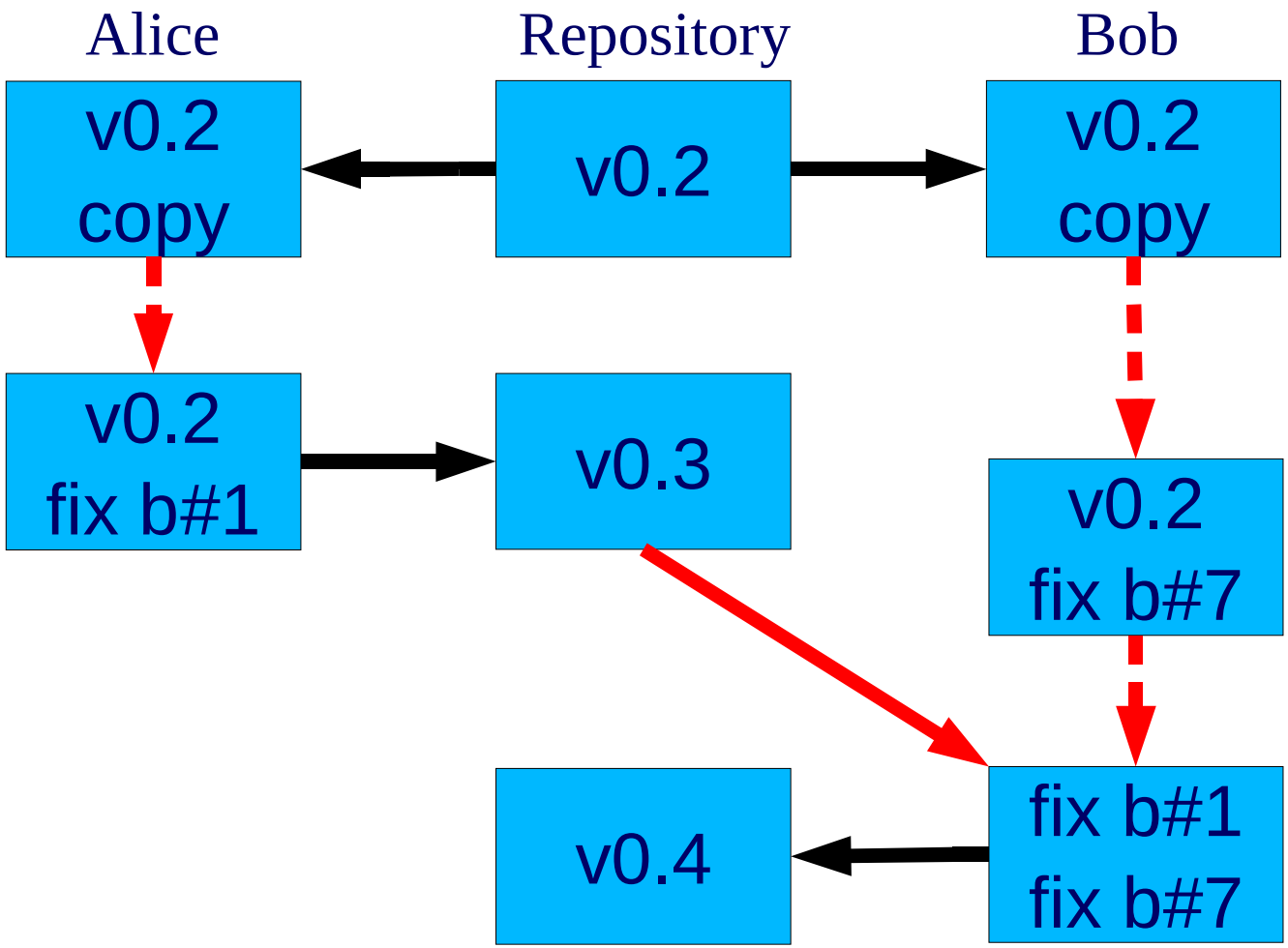
“Arguably Less Wrong”



Merge, Bob, Merge!



Committing Genuine Progress



How?

Keep a global repository for the project.

Each user keeps a working directory.

Concepts of *checking out*, and *checking in*

Mechanisms for *merging*

Mechanisms for branching

Branching

A branch is a *sequence of versions*

- **(not really...)**

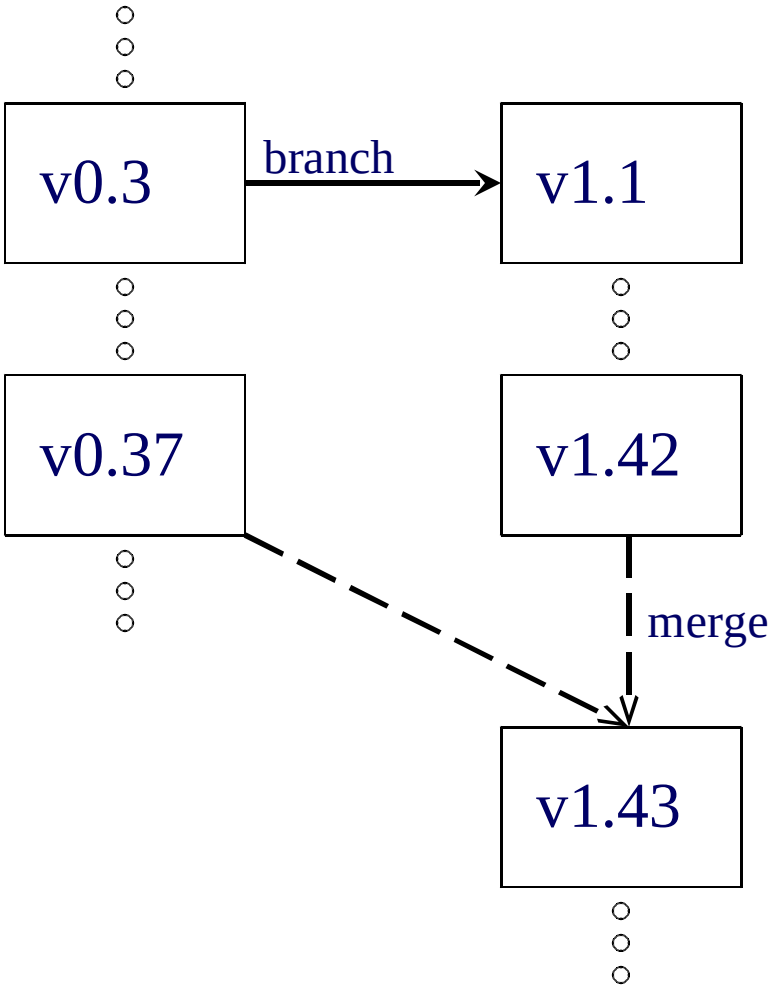
Changes on one branch don't affect others

Project may contain many branches

Why branch?

- **Implement a new “major” feature**
- **Begin a temporary independent sequence of development**

Branching



The actual branching and merging take place in a particular user's working directory, but this is what such a sequence would look like to the repository.

Branch Life Cycle

"The Trunk"

- **"Release 1.0", "Release 2.0", ...**

Release 1.0 *maintenance* branch

- **After 1.0: 1.0.1, 1.0.2, ...**
- **Bug-fix updates as long as 1.0 has users**

Internal *development* branches

- **1.1.1, 1.1.2, ...**
- **Probably 1.1.1.client, 1.1.1.server**

Branch Life Cycle

"Development excursion" branch model

- **Create branch to fix bug #99 in v1.1**
- **One or more people make 7 changes**
- **Branch "collapses" back to trunk**
  - **Merge 1.1.bug99.7 against 1.1.12**
  - **Result: 1.1.13**
  - **There will be no 1.1.bug99.8**
    - In some systems, there *can't* be

Branch Life Cycle

"Controlled isolation" branch model

- Server people work on 1.3.server
  - Fix server code
  - Run stable client test suite vs. new server
- Client people work on 1.3.client
  - Fix client code
  - Run new client test suite vs. stable server
- Note
  - Branches do *not* collapse after one merge!

Branch Life Cycle

"Controlled isolation" branch model

- **Periodic merges - example**
  - **1.3.server.45, 1.3.12 ⇒ 1.3.13**
  - **1.3.client.112, 1.3.13 ⇒ 1.3.14**
  - **Each group can keep working while one person "pushes up" a version to the parent**
- **When should server team "pull down" 1.3.14 changes?**
  - **1.3.server.47, 1.3.14 ⇒ 1.3.server.48?**
  - **1.3.server.99, 1.3.14 ⇒ 1.3.server.100?**
  - **Efficiency now vs. merge cost later...**

Branch Life Cycle

Successful development branch

- Merged back to parent
- No further versions

Unsuccessful development branch

- Some changes pulled out?
- No further versions

Maintenance branch

- “End of Life”: No further versions

Are Branches *Deleted?*

Consider the repository "data structure"

- Revisions of each file (coded as deltas)
- Revisions of the directory tree

Branch delete

- *Complicated* data structure update
  - [Not a well-tested code path]
- Generally a bad idea
  - History could *always* be useful later...

Source Control Opinions

CVS

- very widely used
- mature, lots of features
- default behavior often wrong

OpenCM

- security-conscious design
- not widely used

BitKeeper

- ~~Favored by Linus Torvalds~~
- “Special” license restrictions

SubVersion (svn)

- SVN > CVS (design)
- SVN > CVS (size)
- Doesn't work in AFS
- Yes, it does
- No, it doesn't

PerForce

- commercial
- reasonable design
- works well
- big server

Source Control Opinions

Others

- Mercurial (“hg”)
  - Merge-once branches
- Bazaar (“bzr”)
- git
  - Recently revamped
- Monotone
- arch
- darcs

Generally

- Promising plans
- Ready yet?

Dave's Raves

CVS

- Commit: atomic if you are careful
- Named snapshots: if you are careful
- Branching: works if you are careful
- *Core operations* require care & expertise!!!

Many commercial products

- Require full-time person, huge machine
- Punitive click-click-click GUI
- Poor understanding of data structure requirements

Recommendation for 15-410

You can use CVS if you're used to it

- Also: SVN, hg, arch, ...

PRCS, Project Revision Control System

- Small “conceptual throw weight”
- Easy to use, state is visible (single text file)
- No bells & whistles

Setting to learn revision control *concepts*

- Quick start when joining research project/job
  - (They will probably not be using PRCS)

Getting Started

Add 410 programs to your path (.bashrc):

- `$ export PATH=/afs/cs.cmu.edu/academic/class/15410-s08/bin:$PATH`

Set environment variables (also .bashrc):

- `$ export PRCS_REPOSITORY=/afs/cs.cmu.edu/academic/class/15410-s08-users/group-99/REPOSITORY`
- `$ export PRCS_LOGQUERY=1`

Creating A New Project

In a blank working directory:

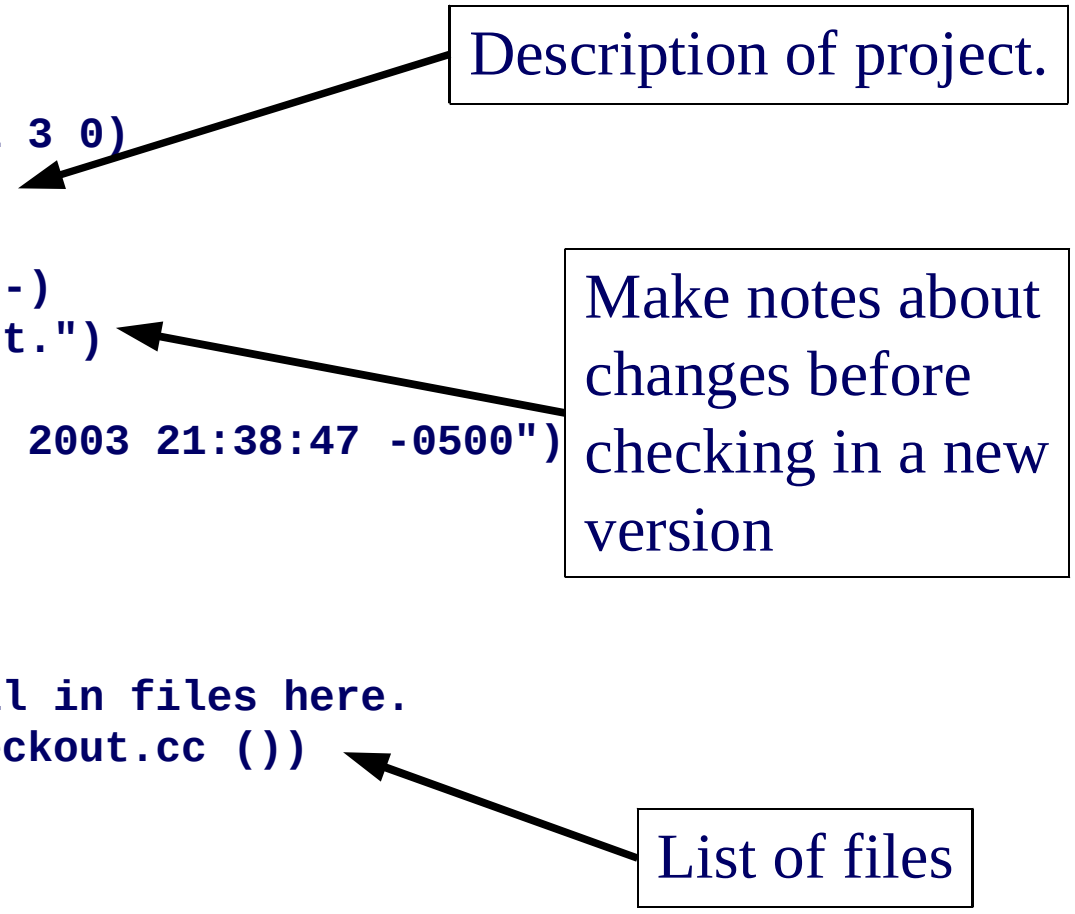
```
$ prcs checkout P
```

- **P is the name of the new project**

Creates a file: P.prj

The Project File

```
;; -*- Prcs -*-
(Created-By-Prcs-Version 1 3 0)
(Project-Description "")
(Project-Version P 0 0)
(Parent-Version -*- -*- -*-)
(Version-Log "Empty project.")
(New-Version-Log "")
(Checkin-Time "Wed, 15 Jan 2003 21:38:47 -0500")
(Checkin-Login zra)
(Populate-Ignore ())
(Project-Keywords)
(Files
;; This is a comment.  Fill in files here.
;; For example:  (prcs/checkout.cc ())
)
(Merge-Parents)
(New-Merge-Parents)
```



Using the Project File

Adding Files

```
$ prcs populate P file1 file2 … fileN
```

- To add *every* file in a directory
  - `$ prcs populate P`
  - Rarely what you want!!!

Removing, renaming files

- See course web

Checking In

Checking in

```
$ prcs checkin P
```

- Check-in will fail if there are conflicts.
- Hey, we forgot to talk about conflicts!

Conflicts and Merging

Suppose this file is in the repository for project P:

```
#include <stdlib.h>
#include <stdio.h>

int main(void)
{
        printf("Hello World!\n");
        return 0;
}
```

Conflicts and Merging

Suppose Alice and Charlie check out this version, and make changes:

Alice's Version

```
#include <stdlib.h>
#include <stdio.h>

#define SUPER 0

int main(void)
{
        /* prints "Hello World"
           to stdout */
        printf("Hello World!\n");
        return SUPER;
}
```

Charlie's Version

```
#include <stdlib.h>
#include <stdio.h>

int main(void)
{
        /* this, like, says
           hello, and stuff */
        printf("Hello Hercules!\n");
        return 42;
}
```

Conflicts and Merging

Suppose Alice checks in first

```
$ prcs checkin
```

Now Charlie must perform a merge

```
$ prcs checkin ⇒ will fail
$ prcs merge
```

- Default merge option performs a CVS-like merge.

```
$ prcs checkin ⇒ should work now
```

Merge Mutilation

```
#include <stdlib.h>
#include <stdio.h>

#define SUPER 0

int main(void)
{
<<< 0.2(w)/hello.c Wed, 19 Feb 2003 21:26:36 -0500 zra (P/0_hello.c 1.2 644)
        /* this, like, says hello, and stuff */
        printf("Hello Hercules!");
        return 42;
===
        /* prints "Hello World" to stdout */
        printf("Hello World!");
        return SUPER;
>>> 0.3/hello.c Wed, 19 Feb 2003 21:36:53 -0500 zra (P/0_hello.c 1.3 644)
}
```

Conflicts and Merging

Pick/create the desired version

- **Check that into the repository.**

Branching

To create the first version of a new branch:

```
$ prcs checkin -rExperimental_VM
  Kern.prj
```

To merge with branch X version 37:

```
$ prcs merge -rX.37 Kern.prj
```

Information

To get a version summary about P:

```
$ prcs info P
```

- **with version logs:**

```
$ prcs info -l P
```

Suggestions

Develop a convention for naming revisions

- Date
- Type of revision(bug-fix, commenting, etc.)
- Short phrase

When to branch?

- Bug fixing?
  - Check out, fix, check in to same branch
- Trying COW fork since regular fork works?
  - Branching probably a good idea.
- “Any time you want commits kept secret”

Summary

We can now:

- Create projects
- Check source in/out
- Merge, and
- Branch

See PRCS documentation

- Ours, official –on Projects web page
- Complete list of commands
- Useful options for each command.